**AP Biology – Cellular Respiration Lab**

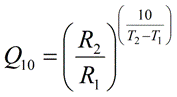
Cell respiration is the process by which organisms catabolize organic molecules into the more efficient ATP molecule that can be used to power nearly all biological processes. In most organisms oxygen is used to oxidize (extract energy-rich electrons) these organic molecules and carbon dioxide is released as a byproduct when the organic molecules are oxidized. Oxygen then combines with available hydrogens to form water as another waste product. The overall equation for this reaction is shown below:



Although the terms **ectotherm** and **endotherm** are usually used to describe *animal* body temperature regulation, they can also be used to describe plants. Most plants cannot regulate their body temperature internally and are therefore at the mercy of their surroundings to absorb heat energy to assist cellular processes. There is a relationship between metabolic rate and temperature in ectotherms called Q10 – The Temperature Coefficient. Simply stated, **for every 10oC change in temperature, a corresponding change in metabolic rate occurs.** **The change factor (Q10) is usually 2-3 in biological systems**. An example is shown below:

The invertebrate crustacean *Daphnia* *magnum* has a Q10 of about 2 meaning that for every 10oC increase in temperature, its metabolic rate increases by a factor of 2. Notice however this only occurs up to a certain temperature. **Explain this observation.**





Assume that **X = 1** in the graph data.

**Use the data to show your calculation of the Q10 value for *Daphnia* between 20 & 30oC** (T2 = higher temperature & T1 = lower temperature, R2 = metabolic rate at T2, R1 = metabolic rate at T1)

**How might this data differ for an endotherm such as a mouse?**

The purpose of this experiment is to determine if metabolic rate in ectotherm fish will change based on temperature and if so whether or not it follows the Q10 rule.

**Write a null hypothesis appropriate for the first part of the purpose. How will it be tested? How will you determine if fish follow the Q10 rule?**

**Methods**

Your group will measure respiration rate based on oxygen consumed over time using a dissolved oxygen sensor. **There is only 1 sensor**, so follow the time schedule shown carefully. The basic procedures are described on the following page. **Failure to adhere to your time schedule for any reason will result in a 25% DEDUCTION from your lab performance grade.** **I will be available after school Monday if you would like to practice.**

**DAY 1 – FISH RESPIRATION RATE AT 20oC**

1. Your materials tray includes: a cup of water with a fish, a cup of ice/water, a thermometer & an experimental cup with holed- lid. You also have an extra tray for excess water during the experiment.

2. Fill the experimental cup with tap-water until almost full; IN A TRAY, add ice-water **SLOWLY** to the experimental cup until temperature is at **19oC**. Hot water is available if temperature gets too cold.

3. Cover with the lid; Fill with ice water through the lid hole until water spills out of the hole on top of the lid to assure the entire cup is filled with water and no air.

3. Check water temperature is **19oC**; cool with ice if not. When at **19oC**, remove the lid, add the fish and replace lid. Start a timer for 2 minutes for fish to acclimate to the water.

4. Have the fish cup at the oxygen sensor table so that when the 2 minutes have elapsed, I can take a reading right away. I will take an average reading of oxygen over **90s** and tell you the number; then start the timer again for 10 minutes. You can then return with the fish cup to your lab table.

6. Record the oxygen value I measured with the sensor. This is the initial oxygen value at *20oC*. During the experiment the temperature will increase about 1 degree; therefore, starting it at 19 degrees assures the average experimental temperature is about **20oC**.

7. Have the fish cup at the oxygen sensor table so that when the 10 minutes have elapsed, I can take a reading right away. I will take another average reading of oxygen over **90s** and tell you the number; you can then return with the fish cup to your lab table.

5. Replace the fish into its original room temperature water cup, dump out water/ice from trays & experimental cup into sink. Place all empty materials into the tray to dry and leave the fish cup in the tray.

**DAY 2 – FISH RESPIRATION RATE AT 30oC**

1. Your materials tray includes: a cup of water with a fish, a cup of ice water, & an experimental cup with holed- lid & hot water. You also have an extra tray for excess water during the experiment.

2. Follow the same procedures as day 1 except temperature should be at **32oC** for your first oxygen reading. Heat will be lost more quickly so the temperature may go from 32-28 degrees during the trial, but the average will be about 30 degrees. Use the provided hot water (42oC) & ice-water to adjust temperature prior to your first reading.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Group | Time @  fish into cup | Time @  initial reading | Time @ start 10 minute timer | Time @ final reading | 20oC Respiration Rate  (O2/minute) | 30oC Respiration Rate  (O2/minute) |
| 2 | 7:38 | 7:40 | 7:42 | 7:52 |  |  |
| 3 | 7:41 | 7:43 | 7:45 | 7:55 |  |  |
| 4 | 7:44 | 7:46 | 7:48 | 7:58 |  |  |
| 5 | 7:47 | 7:49 | 7:51 | 8:01 |  |  |

20oC Trial Initial O2 reading \_\_\_\_\_\_\_\_ mg O2/L H2O Final O2 reading \_\_\_\_\_\_\_\_ mg O2/L H2O

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30oC Trial Initial O2 reading \_\_\_\_\_\_\_\_ mg O2/L H2O Final O2 reading \_\_\_\_\_\_\_\_ mg O2/L H2O

**Statistical Analysis**

Calculate the respiration rate for each different temperature ([Final-Initial O2]/10). Record the data for all other groups above. For the t-test website, the cold temperature values should be input into the first box and the warm temperature values should be input into the second box. The p-value should be used to reject or accept your null hypothesis. You can also **obtain the standard deviation** to *calculate standard error* for error bars on your figure.